

**QUANTITATIVE DATA CONCERNING THE OVIPOSITION OF  
*BOMBYLIUS FIMBRIATUS* MEIGEN (DIP.: BOMBYLIIDAE), A  
PARASITE OF *ANDRENA AGILISSIMA* (SCOPOLI)  
(HYM.: ANDRENIDAE)**

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**Summary**

*Bombylius fimbriatus* Meigen females were observed at Isola d'Elba parasitising the nests of *Andrena agilissima* (Scopoli). Bee fly oviposition occurred around noon and usually a single egg (sometimes a few of them) was thrown into each opening. The fly did not seem to be able to discriminate between the *Andrena* nest openings and any other dark spot of comparable size. Mean time spent in hovering flights in front of the nests and in oviposition has been calculated from filmed sequences. On the base of quantitative data some inferences have been drawn regarding a few other aspects of oviposition behaviour.

**Introduction**

Bee flies (Diptera: Bombyliidae) parasitise other insects, especially Orthoptera, Lepidoptera, Coleoptera, Hymenoptera and Diptera, and *Bombylius* seems specialised in attacking solitary bees and, less usually, wasps (Hull, 1973).

Although some species of *Bombylius* are widespread and easily observed, few data are available about their behaviour. Dufour (1858) gave the first account of the life history of a *Bombylius* (*B. major* L. living at the expenses of an *Andrena*); since then little and scattered information is available.

A description of the oviposition in *Bombylius* was briefly reported by Chapman (1878) (*B. canescans* Mikan parasitising the solitary wasp *Odynerus spinipes* L.), Séguy and Baudot (1922) who saw *B. vulpinus* Wiedemann (as *fugax* Wiedemann) throwing its eggs into the nest of the bee *Panurgus dentipes* Latr., Scott (1952) and Knight (1968). Associations between a *Bombylius* and an *Andrena* host were reported among others, by Chapman (*op. cit.*: *B. major* L. and *A. labialis* (Kirby)). Knight (*op. cit.*: *B. major* L. and *Andrena* spp.), Bonelli (1964: *B. canescens* Mikan and *A. humilis* Imhoff) and Litt (1988: *B. major* L. and *A. fulva* (Müller)). Further references are listed in Du Merle (1975), yet no data have ever been published about *B. fimbriatus* Meigen, nor about *Andrena agilissima* (Scopoli) being a host of *Bombylius*.

In this paper we provide some quantitative information about oviposition of *Bombylius fimbriatus*.

### Materials and Methods

Observations were carried out in the period 2/9 May 1993 at Isola d'Elba (Toscana, Italy) near a crossroad between the towns of Cavoli and Marina di Campo where an aggregation of some 130 nest openings of *Andrena agilissima* was found on an earth wall 2.5 metres high and six metres wide, facing south-west.

During our observations the soil temperature of the site varied on the average from 18°C (at 10.00am) to 21°C (at 5.00pm). In the same period the air temperature varied between 17°C and 23°C.

Above the earth wall there is a holm oak *Quercus ilex* wood, surrounded by typical Mediterranean scrub (cisto-lavanduletea) with *Lavandula stoechas*, *Cistus salvifolius*, *C. monspeliensis*, *C. incanus*; the wall is fully devoid of vegetation. At Isola d'Elba precipitations in May-June are usually less than 25mm; overall annual precipitations are usually about 700mm.

The site was visited every day from 8.30am to 5.30pm. Bee flies were filmed when close to the bee nests by means of a SONY Video Camera Recorder Hi8 CCD-V800E.

Analysing the tape by means of a video recorder we calculated the number and duration of the "wait time", and of the "oviposition time". The "wait time" is the time that the bee fly spends hovering in front of an *Andrena* nest hole (or a wrong target) before throwing its egg; the "oviposition time" is the combined duration of the movements of the *Bombylius* female laying her egg: she suddenly lowers, pushes her abdomen forward hurling an egg to the bee nest and finally returns to a horizontal position. "False waits" (hovering flights not followed by oviposition) were also counted.

Lastly we recorded how many times a bee fly female laid into the same hole and we noticed whether the egg was directed towards either an *Andrena* nest ("right target") or an "wrong target", i.e. any dark object or spot different from a bee nest opening.

### Results and Discussion

*Bombylius fimbriatus* females arrived at the bee nests around 11.30am and stayed there until about 1.30pm (solar time). Their presence at the site was observed during that time period only.

Since we did not mark *Bombylius* females, we cannot tell the number of different flies to which data refer, and whether the individuals present on different days were the same or different ones; however, we never saw more than two bee flies hovering simultaneously over the wall.

The sequences showing *Bombylius* behaviour last 21 minutes and 1 second in total; 102 filmed sequences, varying in length from one second to one minute and 14 seconds were examined. Data summarised in Table 1 are concerned with all observed sequences, either complete or incomplete. However, to calculate the mean "oviposition time" and the mean "wait time"

we used uniquely complete sequences showing full behavioural acts filmed from the beginning to the end, whose time length could be determined; incomplete sequences were discarded. The employed values included 184 ovipositions, either into "right" or "wrong targets" (114 resulted incomplete if compared with those, for a total of 298, see Table 1) and 251 waits followed from oviposition (either into "right" or "wrong targets") (47 incomplete, for a total of 298, see Table 1); 16 "false waits" were also considered (three incomplete, for a total of 19, see Table 1). Complete sequences of ovipositions into true nests ("right targets") were 111 (31 incomplete, for a total of 142, see Table 1), into "wrong targets" were 27 (12 incomplete, for a total of 39, see Table 1).

The average frequency of oviposition was 298 (number of ovipositions) in 1261 seconds (duration of the film) = 0.236 per second. That means that *Bombylius* "swooped" once every 4.2 seconds on the average. This value could be overestimated for it is referred just to the filming of *Bombylius* when it was detected near the nests of *Andrena*.

The average "oviposition time" was 0.087 seconds ( $n = 184$ , range 0.04-0.12,  $SD = 0.02$ ), and the average "wait time" was 2.24 seconds ( $n = 251$ , range: 0.16-7.32,  $SD = 1.06$ ).

The frequency distribution of the oviposition during the day did not show any significant pattern and it maintained a constant rhythm when the fly stayed close to the bee nests.

Usually *Bombylius* laid only once per opening, afterwards it often moved to a new target. When more than one egg was thrown into the same hole (see Table 1, fourth column), it was difficult to understand which stimuli cause the bee fly to lay more than once.

Though at the beginning of its stay close to the *Andrena* nesting site *Bombylius* showed a somewhat lower frequency of oviposition and often hovered without laying, this trend was not statistically significant ( $\chi^2 = 8.43$ , 6 df).

There are no differences between the mean waiting times not followed from an oviposition or followed from it (Mann-Whitney U test = 1602,  $n_1 = 16$ ,  $n_2 = 251$ ,  $p = 0.071$ ).

The choice of the target by *Bombylius* seemed to be primarily linked to the darkness of a point in comparison to that of the surrounding soil. So we often observed the fly throwing an egg towards different small dark spots as rock crevices, stones, roots etc ("wrong targets"). Even if at a first examination the shape did not seem to be an important clue for the fly choice, at a closer analysis some more subtle conditions appear to be at work. In fact *Bombylius* females spent less time waiting in front of an *Andrena* nest opening, before oviposition, than in front of a "wrong target" (Mann-Whitney U test = 2451,  $n_1 = 27$ ,  $n_2 = 111$ ,  $p = 0.002$ ); so probably the right place where to lay eggs could be detected more readily by the flies. Moreover, multiple ovipositions

seem to have been more common into "right targets" (35 compared to one into "wrong targets" and to ten into "undetermined" ones).

The ecological variables that could influence the behaviour of the bee fly have not been examined. For instance, the influence of the air temperature on the oviposition rate should be evaluated. Furthermore we could not see any interaction between the bees, which were very abundant, and the flies; nor whether any kind of competition existed among *Bombylius* females, so few in a large area available for oviposition.

Time Range	Duration of recorded sequences (sec)	No. of acts	No. of ovipositions*	False waits	Right Targets	Wrong Targets	Undetermined Targets**
11.40-11.49am	71	18	14 (2-12)	4	11	5	2
11.50-11.59am	111	31	29 (3-26)	2	8	3	20
0.00- 0.09pm	369	99	93 (13-80)	6	50	14	35
0.10- 0.19pm	388	96	91 (13-78)	5	42	10	44
0.20-0.29pm	210	48	46 (10-36)	2	18	6	24
1.20-1.29pm	82	14	14 (2-12)	0	8	0	6
1.30-1.39pm	30	11	11 (3-8)	0	5	1	5
Total	1261	317	298 (46-252)	19	142	39	136

**Table 1:** Data concerning *Bombylius fimbriatus* oviposition.

\* Values between brackets are respectively the ovipositions directed to the same target (multiple ovipositions) and to different ones (single ovipositions).

\*\* Targets unrecognisable from the analysis of the filmed sequences.

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### **High population densities of Garden Tiger Moth caterpillars *Arctia caja* L. (Lep.: Arctiidae) on Handa Island, Sutherland.**

For a number of years, small numbers of caterpillars of the Garden Tiger Moth *Arctia caja* L. have been recorded by seasonal wardens of the Scottish Wildlife Trust on Handa Island Wildlife Reserve, north-west Scotland. In 1995 and 1996 numbers were unusually high. So dramatic was the black carpet of caterpillars, that it attracted the attention of the national media (e.g. Chalmers, "Something is flutter on island people left in 1848", *Daily Mail*, 10th June, 1995, page 3). High densities of *Arctia caja* caterpillars have been seen elsewhere, on similar dune grasslands on the west coast of Scotland (Mark Young, *pers. comm.*). Data was collected on population densities and foodplant preferences in order to provide baseline information for comparison with other sites and future years on Handa. The population on Handa was confined to two, contiguous, and relatively homogenous dune grassland areas (mainly SD6 and SD7 in Rodwell, J (1991 et seq) *British Plant Communities*. 5 Vols. Cambridge University Press).

On the 2.v.1995, 60 x 1m<sup>2</sup> stratified random quadrats were sampled throughout the main area of distribution to estimate density of caterpillars. Within this area there were two density classes: "high", within a dune grassland area adjacent to the open dunes, and "low", within a band of neutral grassland surrounding the dune grassland to the west. The boundary between the two classes was discrete enough to be delineated with the naked eye and mapped.

On the 12.v.96, 100 x 1m<sup>2</sup> stratified random quadrats were sampled (60 in the "high" density area, 40 in the "low" density area). The two areas were again discrete. Also during 1996, the foodplants of the caterpillars were recorded along 2 x 30m transects in the high density area, as well as more casually over the spring and early summer. The results are summarised below.